

PDM EXHIBITION, 30 MAY 2012

ROTOMOULDING SEMINAR



ROTOMOULDING MATERIALS

Challenges & Opportunities

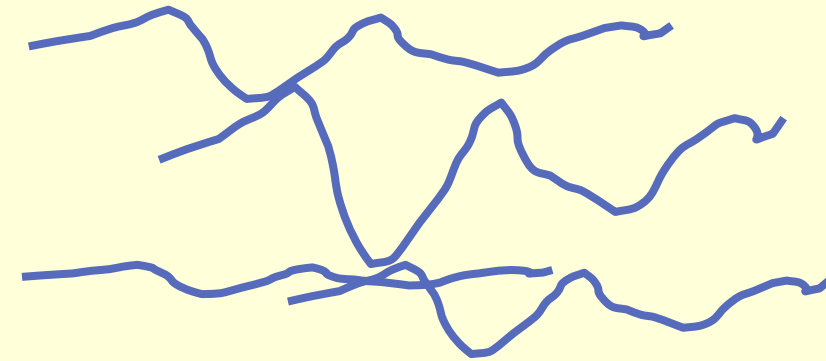
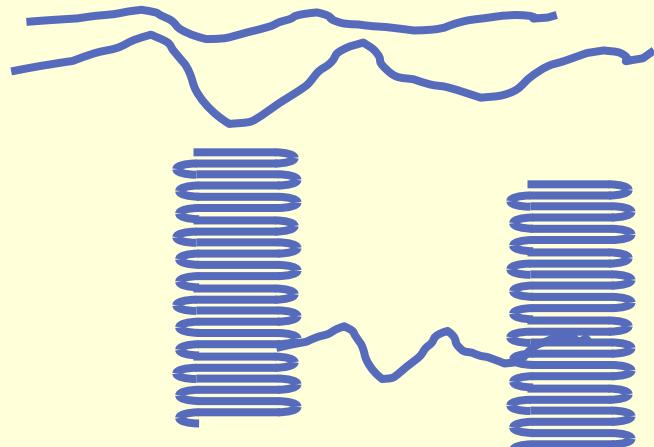
Dr Nick Henwood, Rotomotive Limited


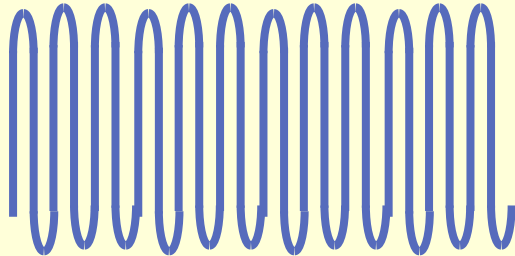
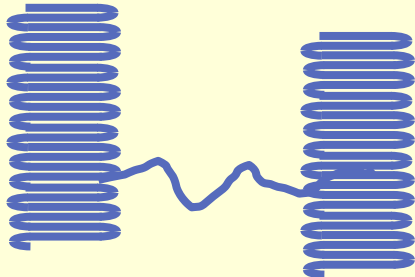
MAJOR MATERIALS ISSUE

- **PE represents 95%+ of all material used in rotomoulding**
- **Very few alternatives to PE available, all have serious “snags”**
- **Relative flexibility of PE is a major issue for designers of large parts**
- **Limited strategies exist for enhancing stiffness of PE mouldings**

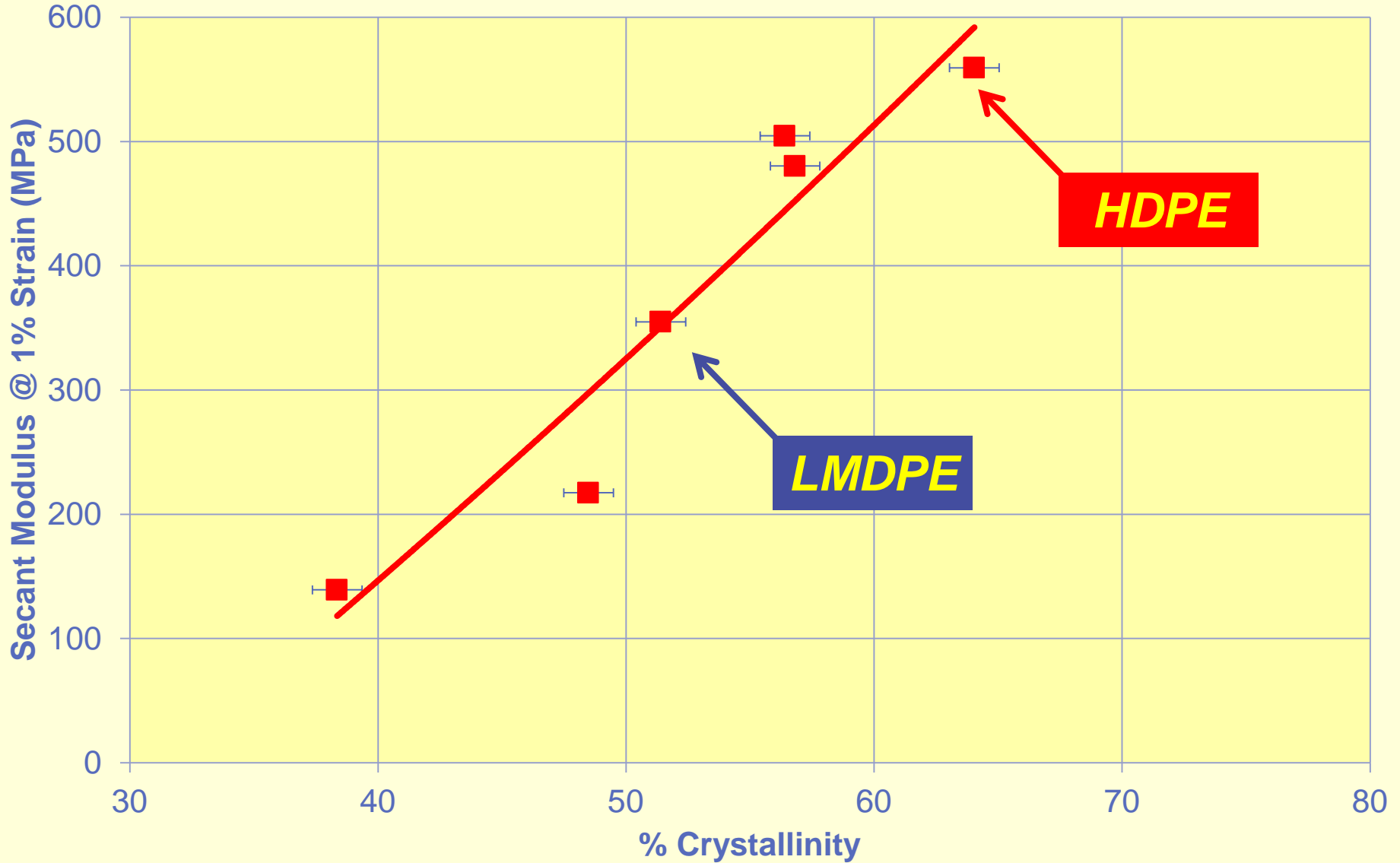
POLYETHYLENE

- PE is a semi-crystalline polymer
- Solid PE contains areas that are crystalline & areas that are amorphous
- Crystalline areas are responsible for stiffness
- Amorphous areas are responsible for toughness
- Cooling can affect crystallinity balance

<p>Melt State of PE</p>	<p>Totally Amorphous</p>	
<p>Solid State of PE</p>	<p>Partially Amorphous</p> <p>Partially Crystalline</p> <p>Tie Molecules</p>	

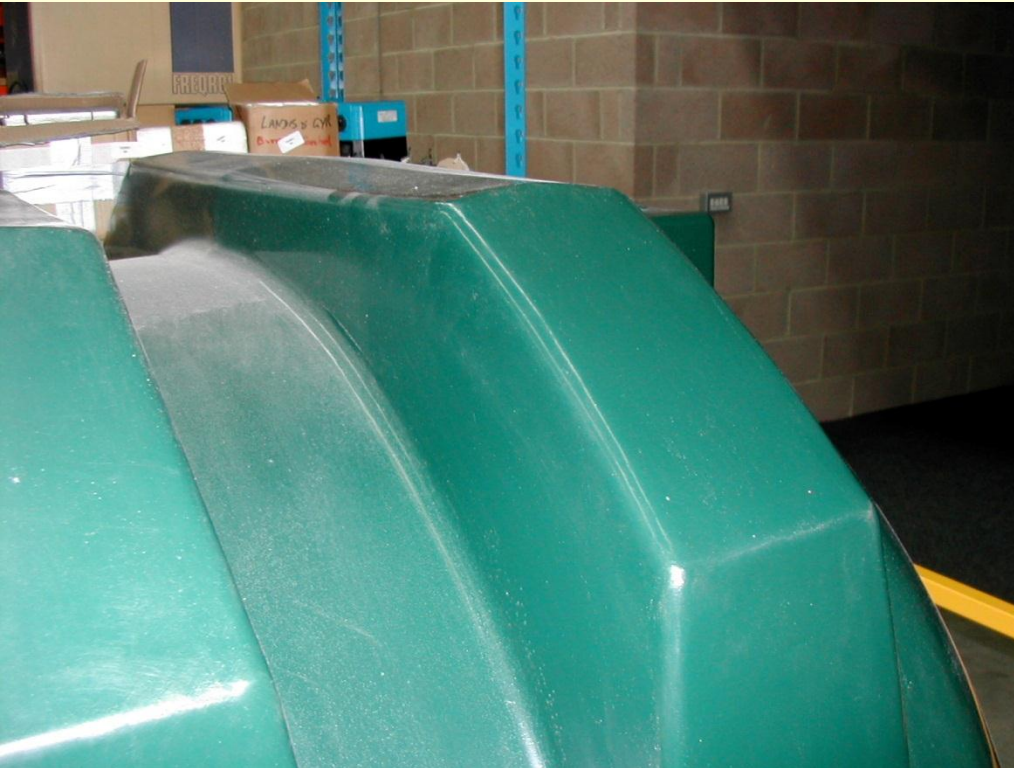
		Increases
Amorphous Phase		Flexibility Transparency Ductility Long-term properties
Crystalline Phase		Stiffness Opacity Brittleness Shrinkage
Tie Molecules		Ductility Resistance to fatigue Long-term properties ESCR

Stiffness vs. Crystallinity for PE Grades



STIFFNESS ENHANCEMENT

RIBS



MULTI-LAYER

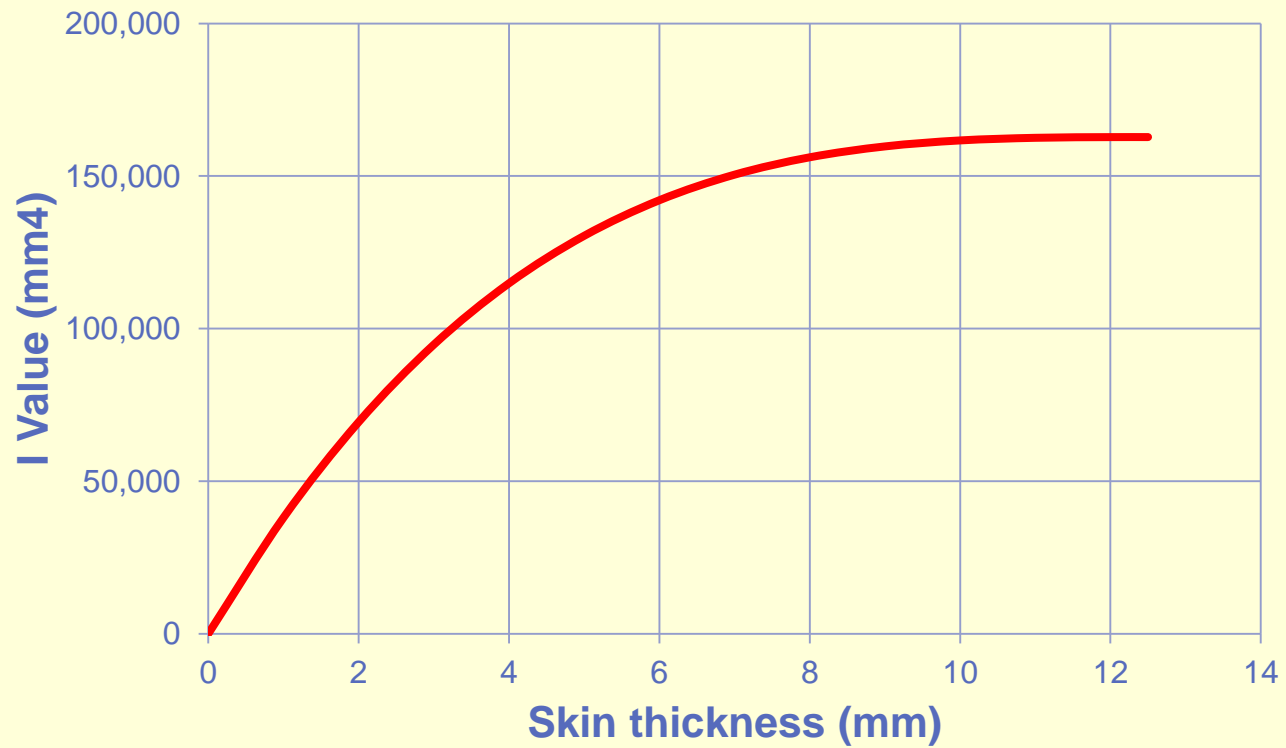


USE OF MULTI-LAYER FOAM

- PE skin-PE foam-PE skin sandwich
- Improves stiffness with low weight
- Lack of hard data on potential improvements
- “As good as solid skin” ?????
- “High stiffness foams” ?????

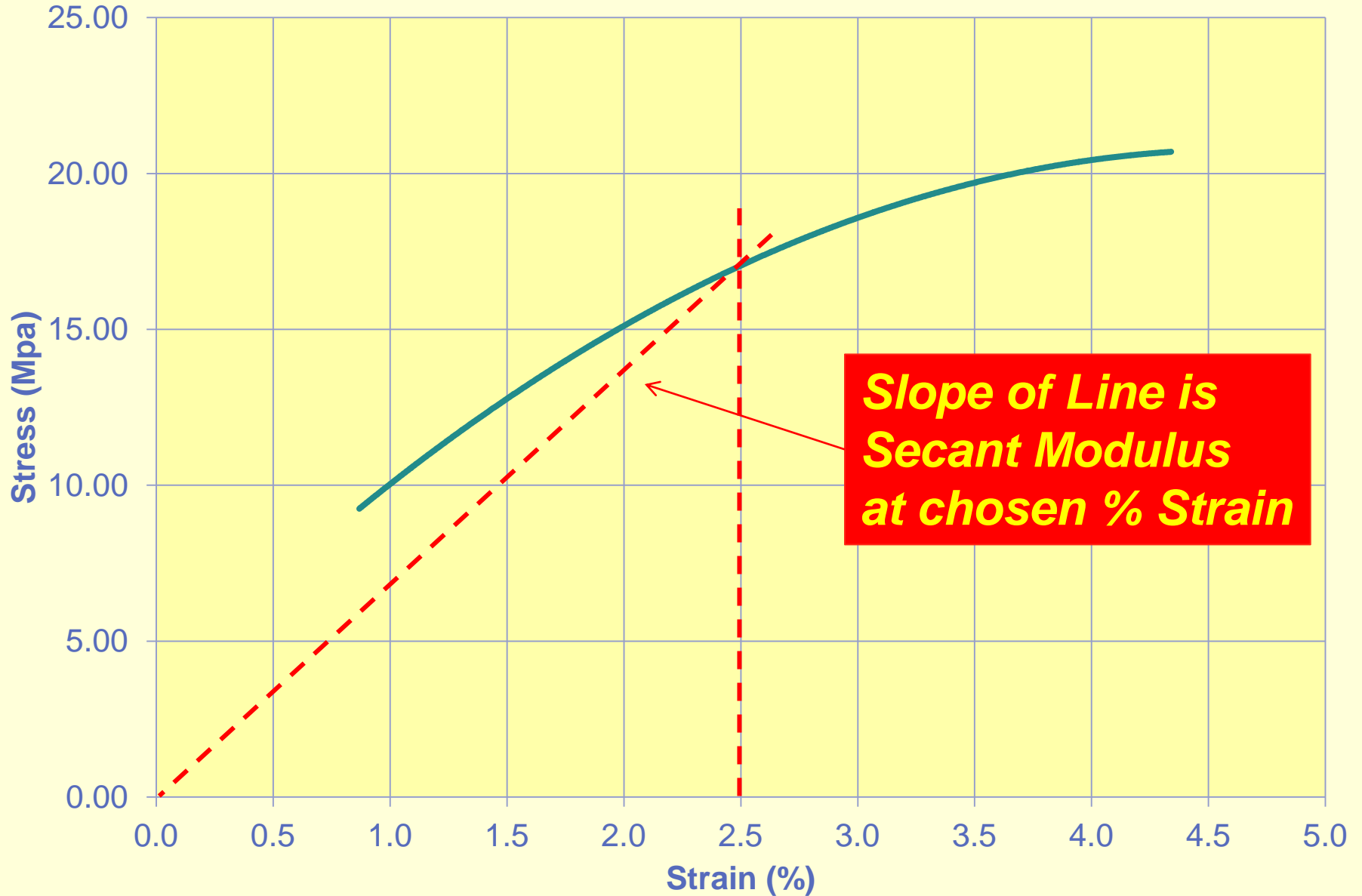
“PLANK” TESTING

- Rotomoulded planks, 125 mm x 25mm section, variable skin thickness
- 3-point bend test, 400mm span, 5 replicates, near-ASTM conditions
- Can evaluate multi-layer structures
- Larger scale possible than typical tests
- Demonstrates good correlation with full-size moulding tests

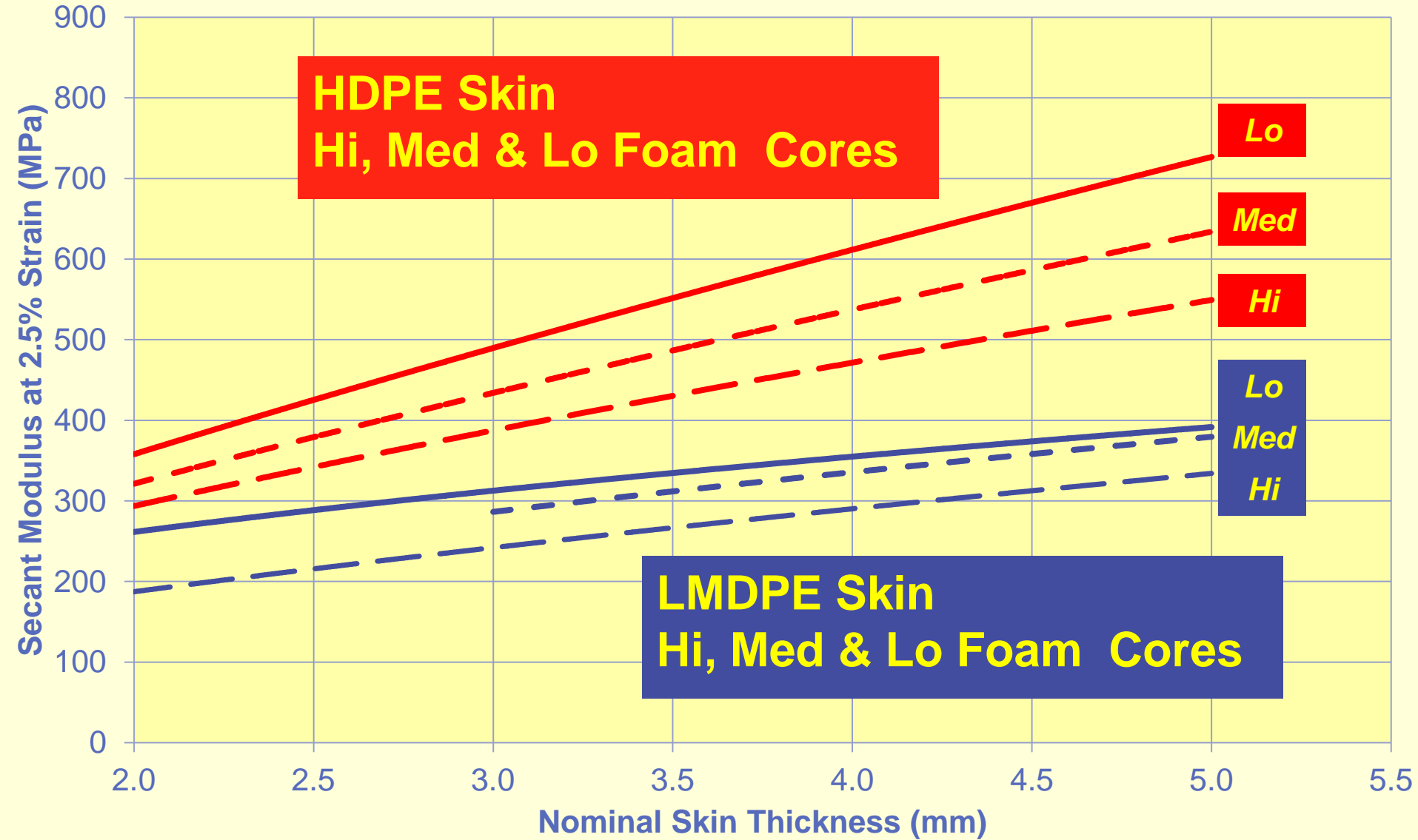




Typical Stress – Strain Curve for Rotomoulded Plank



Effect of Skin Thickness & Core Formulation



CONCLUSIONS

- Inherent flexibility of PE is an issue
- Changing PE grade has limited effect
- Use of foam sandwich enhances stiffness
- Stiffness mainly due to skin, not foam
- Foam stiffness is much lower than skin stiffness
- Lack of design data makes designers uncertain
- “Plank” testing can produce much more realistic evaluations

HOW ROTOMOTIVE CAN HELP

- **Research & consultancy organisation, focused 100% on rotomoulding**
- **Research links with university-based polymer science & FEA design teams**
- **Able to manufacture sample-sized new materials, rotomould them and test them**
- **Experience in evaluating full-sized moulded parts, including creep testing**
- **Able to work alone (in-house funding) and/or with development partners**